REMARKS

Claim Rejections

Claim 7 is rejected under 35 U.S.C. 102(b) as being anticipated by Frohbach et al. (US 5,363,200).

Drawings

It is noted that the Examiner has accepted the proposed drawings filed on April 13, 2005.

Claim Amendments

By this Amendment, Applicant has canceled claim 10 and has amended claims 7-9 and 11 of this application to obviate the objections set forth in the outstanding Office Action. It is believed that the amended claims specifically set forth each element of Applicant's invention in full compliance with 35 U.S.C. § 112, and define subject matter that is patentably distinguishable over the cited prior art.

Explanation of FsinΘ Lens

The following explanation is provided to explain why the applicant used the term "FsinΘ" to define the new lens accompanying the MEMS oscillatory mirror (22) of the invention and why the FΘ lens was replaced with the FsinΘ lens.

Fig.1 shows the relationship between θ and t is different in a laser scanning unit with a polygon mirror and a MEMS mirror. In the case of polygon mirror θ is proportional to time t, and in the case of MEMS mirror θ is proportion to Sin (t).

In Fig.2, the dashed line represents a case without compensation by the lens: spot position on image plane Y' is proportional to Tan (θ). Then, in the case of the polygon mirror, Y' is proportional to Tan (t), and in the case of MEMS mirror, Y' is proportional to Tan [Sin (t)]. The solid line represents a case with compensation by the lens: the lens corrects Y' to be proportional to t in the both cases of polygon mirror and MEMS mirror for constant scanning speed of laser spot.

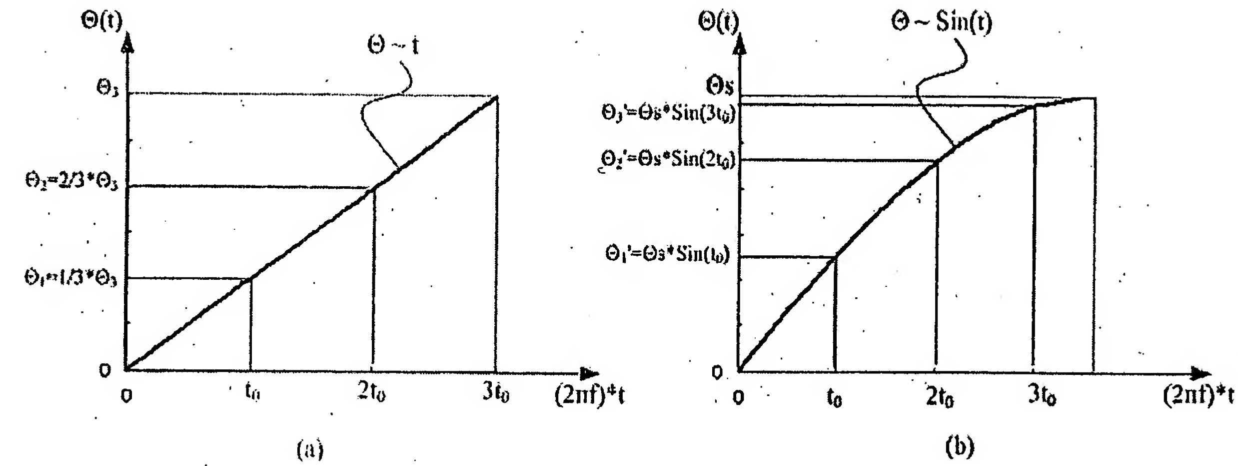

Fig.1 Scanning angle Θ vs normalized time (2πf)*t

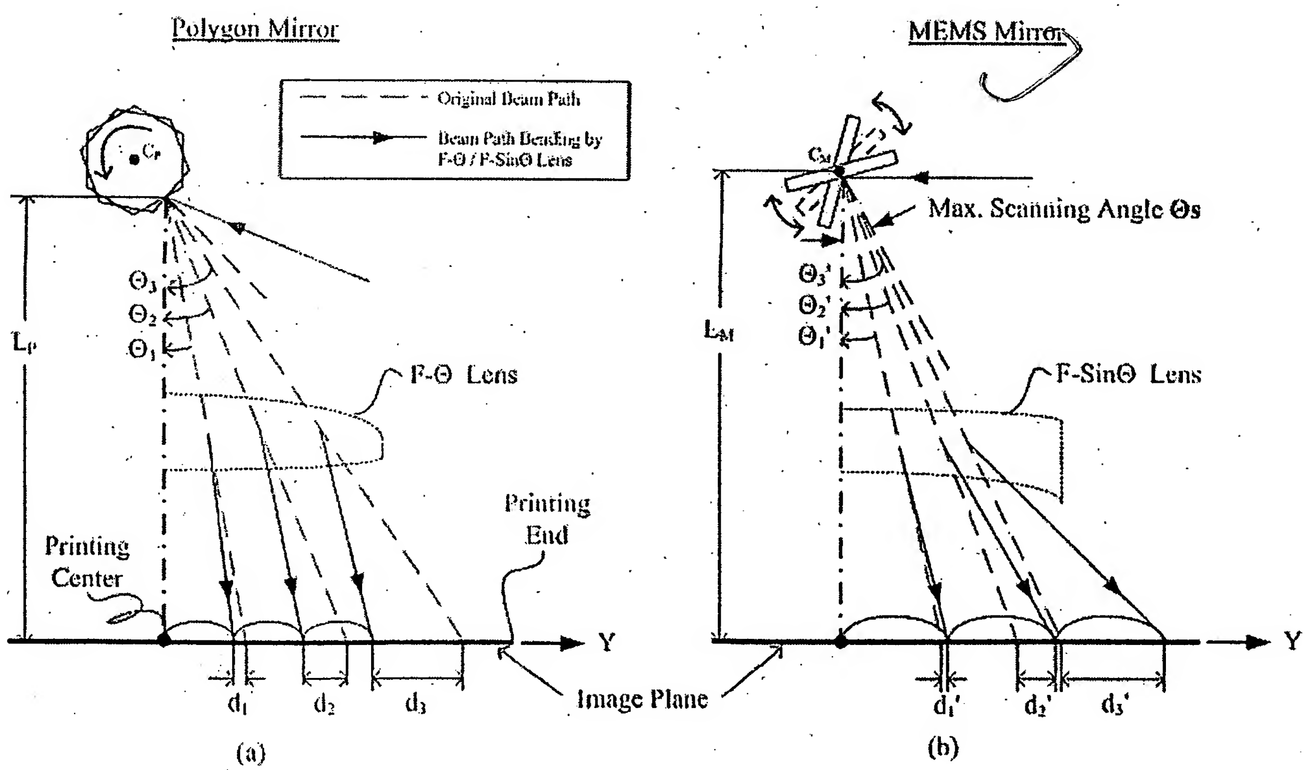

Fig.2 Scanning spot trajectory

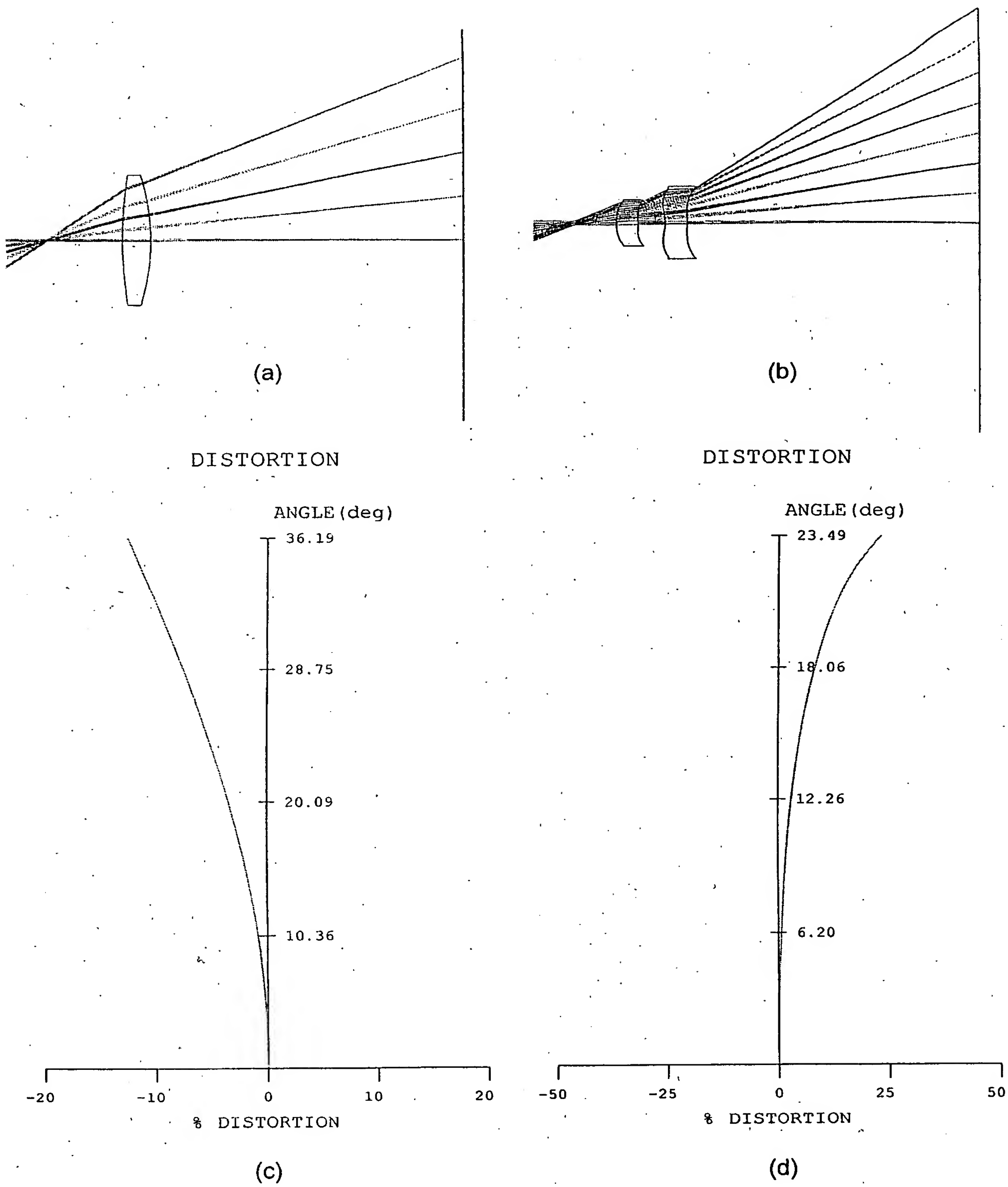

Fig.3 Optical layout and characteristics of F-θ Lens and F-Sinθ Lens

Replacing t as θ, the lens in the case of polygon mirror is called a F-θ lens, and the lens in the case of MEMS mirror is called a F-Sin θ lens. Furthermore, the relationships between these lenses are summarized in Table. 1 below:

Why call the lens a F-Sinθ Lens?

	Polygon Mirror	**MEMS Mirror**
Relation between θ and t	$\theta \alpha\ t$	$\theta \alpha\ Sin(t)$
Spot position in image plane Y' w/o compensation by lens	$Y' \alpha\ Tan(t)$	$Y' \alpha\ Tan[Sin(t)]$
Spot position in image plane Y' with compensation by lens	$Y'=F*Tan(t) \Rightarrow Y' \alpha\ t$	$Y'=F*Tan[Sin(t)] \Rightarrow Y' \alpha\ t$
Call this lens a	F-θ Lens	F-Sinθ Lens

Table. 1

Generally, a polygon mirror with constant rotation speed is adopted in a traditional laser scanning unit (LSU) to reflect the laser beam on OPC (organic photoconductor drum). While the reflective angle of the laser beam with a polygon mirror satisfies the equation below:

E(1) $\Theta(t) = \omega * t$ — ω is the rotation speed of the polygon mirror

As Fig.1 (a) shows, due to a polygon mirror with constant angular speed, i.e. ω is constant, the reflective angle is proportional to time t. That is, the variation of the reflective angle with time is equal in equal time interval. Then the laser beam reflected by the mirror is focused on image plane, and the position of laser spot, i.e. Y', along Y direction satisfies the equation below:

E(2) $Y' = Lp * Tan(\theta(t))$ — Lp is the distance between mirror surface and image plane

As shown by the dashed line in Fig.2 (a), the spot-to-spot spacing increases with time and that means the scanning speed of laser spot on image is not constant but increasing linearly. However, that is not allowed in the optical system of the LSU. We need a lens not only to focus a laser plane beam but also to correct the position of laser spot. Then the spot-to-spot spacing will be equal in equal time interval, i.e. the scanning speed of the laser spot is constant on the image plane and make the position of laser spot Y' satisfies the equation below:

E(3) $Y' = F * \theta(t)$ F is the focal length of lens

As shown by the solid line in Fig.2 (a), the variation of reflective angle is equal in the equal time interval. This special lens with functions of correction of spot size and correcting spot trajectory with constant scanning speed is called a F-θ Lens. As shown in Fig.3(a), from the view of an optical design, the special lens intentionally produces a "negative distortion" or a "barrel distortion", i.e. bending the beam through the F-θ lens from the original beam path toward the printing center. Besides, the positional deviation of the laser spot on the image plane between bent beam and original beam is increasing from center to outer.

We herein reveal a LSU with a MEMS mirror instead of a LSU with a polygon mirror. The behavior of a MEMS mirror which differs from a polygon mirror is a harmonic motion, and the relationship between reflective angle of laser beam θ and time t satisfies the equation below:

E(4) $\theta(t) = \theta s * Sin(2\pi f * t)$ f: the scanning frequency of a MEMS mirror
θs: the extreme scanniing angle of reflection beam

As shown in Fig.1(b), the variation of the reflective angle is not equal but decreasing with sinusoidal function of time t. A complete oscillation of a MEMS mirror is a full period, however, Fig.1(b) shows merely a quarter period, and the reflection angle is the extreme reflective angle θs at this moment.

As shown in Fig.2(b), the position of laser spot Y' satisfies E(2), and from E(4) and E(2) we can get :

E(5) $Y' = LM^* \, Tan\,[\theta s * Sin(2\pi f * t)]$ LM: the distance between the reflective surface of mirror and image plane.

The equation E(5) shows that the spot-to-spot spacing decreases with time, i.e. the scanning speed of laser spot on the image plane is not constant but decreasing with time. However, it differs from polygon mirror. Also a special lens is needed to correct this error and make the scanning speed of laser spot on the image plance to be constant. Due to the variation of reflective angle with sinusoidal function of time, this special lens is called a F-Sinθ lens. The F-Sinθ lens intentionally produces a "positive distortion" or a "pinchshion distortion" in optical design. The laser beam through the F-Sinθ lens will be bent toward printing end from original beam path. As shown in Fig.2(b), the positional deviation of the laser spot on the image plane between the bent beam and original beam is increasing from center to outer.

<u>Rejections Under 35 U.S.C. 102(b)</u>

The cited reference to Frohbach et al. teaches a final focusing lens (50) which is physically translated periodically in a direction parallel to the motion of the medium (52), and the lens (50) is attached to a flexible support (54) which is oscillated at a resonant frequency by a piezoelectric actuator (58 or 61), and a CPU (70) receives input data via a buffer (72) and provides control signals to each of actuator (58, 61) and the laser (60) (column 6 , lines 21-43). In Frohbach et al. the focusing lens (50) is attached to a flexible support (54) and is oscillated with the flexible support (54) at a resonant frequency by a piezoelectric actuator (58 or 61), but in the present invention the FsinΘ lens is fixed in LSU (laser scanning unit) and is not oscillated with a flexible support. Therefore, the present invention is distinguishable from Frohbach et al.

Frohbach et al. do not teach a lens being a FsinΘ lens; nor do Frohbach et al. teach the FsinΘ lens being located in a fixed position in the laser scanning unit.

It is axiomatic in U.S. patent law that, in order for a reference to anticipate a claimed structure, it must clearly disclose each and every feature of the claimed structure. Applicant submits that it is abundantly clear, as discussed above, that Frohbach et al. do not disclose each and every feature of Applicant's new claims and, therefore, could not possibly anticipate these claims under 35 U.S.C. § 102. Absent a specific showing of these features, Frohbach et al. cannot be said to anticipate any of Applicant's amended claims under 35 U.S.C. § 102.

It is further submitted that Frohbach et al. do not disclose, or suggest any modification of the specifically disclosed structures that would lead one having ordinary skill in the art to arrive at Applicant's claimed structure. Thus, it is not believed that Frohbach et al. render obvious any of Applicant's amended claims under 35 U.S.C. § 103.

Summary

In view of the foregoing, Applicant submits that this application is now in condition for allowance and such action is respectfully requested. Should the Examiner not be of the opinion that this case is in condition for allowance, it is requested that this amendment be entered for the purposes of appeal, since it materially reduces the issues on appeal by cancelling claim 10, thereby rendering moot the outstanding rejection under 35 U.S.C. § 102.

Should any points remain in issue, which the Examiner feels could best be resolved by either a personal or a telephone interview, it is urged that Applicant's local attorney be contacted at the exchange listed below.

Respectfully submitted,

Date: December 27, 2005

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